and the solution warmed for a short time upon the water-bath. The alkaline solution is afterwards placed in a flask connected with a condenser and fitted with a dropping funnel. Dilute sulphuric acid is now allowed to slowly drop into the liquid, which is maintained at the boiling temperature. Under these circumstances an aqueous solution of hydrazoic acid distils over. The distillate is allowed to flow into a solution of silver nitrate, when the silver salt, silver azoate, N_3Ag, is precipitated. The silver salt is afterwards dried at 60°–70°, at which temperature no danger attends the operation, and decomposed by sulphuric acid diluted with eight times its volume of water, when hydrazoic acid gas is liberated, contaminated with only a trace of moisture. It appears that the aqueous solution of the free acid is almost as explosive as the silver and mercury salts. Upon one occasion, when attempting to fuse the drawn out end of a tube containing about 2 c.c. of a 27 per cent. solution, Dr. Curtius had a very narrow escape of serious injury, the whole exploding with a fearful detonation, and shattering the glass tube into dust. Several of the azoates explode when a beam of coloured light is thrown upon them; thus barium azoate, BaN_6, explodes when exposed to a strong green light, as does also the still more explosive silver azoate. A concentrated solution of hydrazoic acid appears to be able to dissolve gold, with formation of a red solution of gold azoate.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mr. Charles E. Flower; an Azara's Fox (*Canis azaræ* ♂) from South America, presented by Mr. H. M. Dodington; an Alligator (*Alligator mississippiensis*) from the Mississippi, presented by Mr. A. Schafer; two Black-faced Spider Monkeys (*Ateles ater* ♀ ♀) from Peru, deposited.

OUR ASTRONOMICAL COLUMN.

THE ROTATION OF VENUS.—M. Perrotin, the Director of Nice Observatory, presented a note on the rotation of the planet Venus, at the meeting of the Paris Academy held on October 27. The observations described in the note were undertaken for the purpose of testing the conclusions recently arrived at by Signor Schiaparelli. They extend from May 15 to October 4. In the interval the planet has been observed on 74 days, and 61 maps made of its appearance. The whole of the observed facts leads M. Perrotin to the following conclusions:—

(1) The rotation of the planet is very slow, and is made in such a way that the relative position of the spots and terminator do not experience any notable change during many days.

(2) The time of rotation of the planet does not differ from its sidereal period of revolution (about 225 days) more than thirty days. My observations will easily accommodate themselves, however, to a rotation of which the period is from 195 to 225 days.

(3) The axis of rotation of the planet is almost perpendicular to the plane of its orbit. The displacement of the white region observed at the northern edge indicates that the difference does not exceed 15°, as was admitted by Schiaparelli.

These conclusions, therefore, support those deduced by Schiaparelli from an extended discussion of all the observations of the planet.

SPECTRUM OF THE ZODIACAL LIGHT.—Prof. C. Michie Smith has published a series of observations made at Madras of the spectrum of the zodiacal light (Proc. Roy. Soc. Edinburgh, April 7, 1890). He used a spectroscope specially designed for observing and photographing this spectrum, and records:—"In all my observations, which have been carried on at intervals since 1875, the spectrum has appeared continuous and free from bright lines except during the spring of 1883, and even then the lines were not seen with sufficient distinctness to make their existence certain. The estimated position of the supposed line, wave-length 558, differs but little from that of the auroral line (wave-length 556·7) which was observed by Angström in the zodiacal light spectrum in 1867. He was, however, observing at Upsala, where the auroral spectrum can often be seen in almost all parts of the sky, even when the aurora itself cannot be detected. . . . There would seem to be very little risk of obtaining the auroral spectrum in Madras, and I think that if the bright line seen was real, and not imaginary, it must have been due to the zodiacal light"

These observations indicate a periodic appearance of the 558 line in the zodiacal light spectrum. They also support the idea that the origin of the line is the first fluting of manganese at λ 5576.

D'ARREST'S COMET.—This faint comet (*d* 1890), re-discovered by Mr. Barnard on the 6th ult., may be observed near the following positions:—

Ephemeris for Greenwich Midnight.

1890.		R.A.		Decl.
		h. m. s.		°
Nov. 8	...	21 24 31	...	−27 13·0
12	...	39 15	...	26 40·3
16	...	53 32	...	26 1·4

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Wednesday and Thursday evenings of last week, the 29th and 30 ult., a general meeting of the Institution of Mechanical Engineers was held. The chief business was the reading and discussion of the following two papers: on tube-frame goods waggons of light weight and large capacity, and their effect upon the working expenses of railways, by Mr. M. R. Jefferds, of London; and on milling cutters, by Mr. George Addy, of Sheffield.

Mr. Jefferds is an American engineer who has come over to this country with a view to introduce the tube-frame waggon into England. It should be explained that the tube-frame differs from the ordinary frame of an English railway truck chiefly in the fact that, in place of the timber sole-bars with which we are acquainted, there are used eight wrought-iron tubes, 2⅞ inches in diameter, each pair forming one sole-bar, and suitably connected and supported by malleable cast-iron parts. The boldness with which these castings are used in a structure upon which so much depends bears testimony to the superiority of American foundry practice and to the courage of American designers in perhaps about equal proportions. Certainly no Great George Street engineer would venture upon putting annealed castings in such a position; and, if he did, he would, no doubt, meet with disaster. The tube-frame waggons have, however, been largely built and extensively used in America, and we understand from Mr. Jefferds that there is no reason to think that the castings are not suitable for the work.

The interest in the paper, to judge by the channel into which the discussion was turned, did not centre so much in the constructive details of the waggon described as it did upon the general policy of the American as against the English methods of handling railway freight. In the United States, as most people know, they go upon the principle of having large goods waggons, some even as long as 40 feet and capable of carrying 40 tons. These, however, would be of extreme dimensions, the more usual length being 32 to 34 feet, with a carrying capacity of 30 to 32 tons—that is, American tons of 2000 pounds to the ton. These waggons are mounted on a pair of bogies, each having four wheels. Our own goods trucks are something about 20 feet long, and are mounted on wheels with axles which are fixed with their axes parallel to the ends of the trucks. The English truck will carry 10 tons, and weighs, according to Mr. Jefferds, 8 tons. Mr. Jefferds is, however, a little out here. No doubt some 10-ton trucks weigh 8 tons, but Mr. Williamson, of the Great Western Railway, and Mr. T. Hurrey Riches, of the Taff Vale Railway, state the average weight of their 10-ton trucks to be 5 tons 5 hundredweight and 4 tons 17 hundredweight respectively. Still, making every allowance for errors of this nature, and the possibility of Mr. Jefferds having placed his case in the most favourable light, there is no doubt but that the Americans carry their merchandise over their railways with a far lower proportion of tare to paying load than is the case in England. It has been notorious for years that American railway rates are far below those of this country. We will, however, let Mr. Jefferds speak for himself by making selections from his paper, merely first pointing out the great importance of this question upon our national well-being.

The supremacy of Great Britain—indeed her existence as a Power—is founded upon cheap ocean carriage. We can carry goods across the sea at a lower price than any other people.

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Were we to lose that advantage to-morrow, a large part of our population would be in want of bread within a few months, and there would hardly be an individual in the country whose wealth and comfort would not be lessened. Railway carriage is of next importance, and it is only our insular position and the small size of the country which renders it secondary. There is an impression, well or ill founded, that railway goods carriage might be conducted with more economy in England; and when an American expert comes to us to show how, in his opinion, an improvement may be made, he is worthy of our best attention.

Mr. Jefferds begins his paper by pointing out that the present build of goods trucks on English railways differs nothing in principle, and but little in construction, from the truck made by George Stevenson to carry the barrel of water required for replenishing the *Rocket's* boiler. This, perhaps, is rather an exaggerated statement, but there is more truth in it than we find it pleasant to acknowledge. In America, however, such vehicles, as we have already said, are no longer seen. "Since 1865, the railway rates of the United States have," the paper says, "been reduced fully 79 per cent.; so that the railways are now rendering for £21 the same service for which in 1865 they charged £100. The reason they have been able to make so great a reduction is that they have gradually improved their goods waggons, which would formerly carry loads of their own weight only, but will now carry three or four times as much. . . . In 1889 the average rate charged for all descriptions of goods on all the railways of the United States, including terminal charges, was only 0·488*d.* per ton mile, while the average cost to the railways was only 0·311*d.* The average dividend on highly inflated shares was 3·3 per cent." Turning to individual instances, Mr. Jefferds selects three prominent American lines—the New York Central, the Pennsylvania, and the Philadelphia and Erie. The working expenses per ton mile on these were 0·28*d.*, 0·201*d.*, and 0·176*d.* respectively. The working expenses per ton mile on our London and North-Western Railway are 0·65*d.* per ton mile, or three times as much as the great American line, the Pennsylvania. When one thinks how many millions two-thirds of the cost of goods carriage in this country amounts to, one begins to grasp the magnitude of the question. According to Mr. Jefferds, all this vast sum may be saved by the use of his carriage, although he only claims a modest 9 per cent. for his particular tube-frames.

The average Englishman often wonders how it is American farmers can send wheat right across the Atlantic and undersell British growers comparatively on the spot, and that more especially since agricultural rents have so gone down that farms can be got at purely nominal rents. Here, however, is a fact, according to Mr. Jefferds's paper, which may help to throw some light on the question:—"At the present time, for every hundred tons of grain he sends to London, a farmer living 1000 miles inland in the United States has an advantage of £30, after paying both land and ocean transit, over a farmer living at Stirling in Scotland, only 420 miles from London."

The benefits promised by Mr. Jefferds, if we use his big bogie waggons, are, indeed, immense, but the price we shall have undoubtedly to pay for these benefits is immense also. In the first place, it would be very difficult—practically, we think, impossible—to run these long waggons in mixed trains with the English trucks. The difficulties are mechanical—the principal one being the system of buffing—but we have not space to enter upon them here. Therefore these long bogies could only be brought in by a very sweeping change. What would this involve? Nearly the whole of the usual appliances on the permanent way would have to be entirely reconstructed. Sidings and platforms would be too short, points would have to be altered, locking bars and switching apparatus would have to be replaced, turntables would be too small, hydraulic hoists not sufficiently powerful, even if large enough, and weighbridges would have to be replaced, coal-tips rebuilt—in fact, English railway lines would want reconstructing so far as the appliances for dealing with goods traffic are concerned.

There is, however, another salient feature to consider before we can take Mr. Jefferds and his big bogies to our bosom.

The goods traffic of America is more in bulk than that of England, as might be expected in comparing a comparatively new and sparsely peopled country with one older and more crowded. A 30- or 40-ton waggon can be loaded at St. Louis, Chicago, or elsewhere, and sent through to New York. The journey is long enough to make a big car worth filling. In Britain the conditions are different. During the discussion, one English railway manager said the average lading of general merchandise on his line was not much above 2 tons; another, Mr. Williamson, of the Great Western Railway, gave 2½ tons as a fair average. Mr. Jefferds retorts to this that no one expects a truck to go with only one parcel; the trucks can be filled even if it takes the goods of twenty consignees to make a load. Here again another question arises—Do the Americans pay for cheapness by delay? In England a merchant or manufacturer expects goods given over to the Company one afternoon to be delivered the next day (perhaps his expectation is not always fulfilled); but in America, we are told, no such expedition is observed. May not this be due to the fact that a big waggon is often waiting for the last hundredweight or two to make up its load?

The fact is, the question wants treating quantitatively, and for this purpose a vast mass of statistics must be accumulated; for Mr. Jefferds has only touched the fringe of the question. The arguments he has advanced are, however, sufficiently powerful to have made out a very strong *primâ facie* case—most distinctly a case for inquiry. The railway authorities of this country are the only persons who can supply the details by means of which the problem can be adequately discussed.

The discussion on Mr. Jefferd's paper occupied the greater part of the two evenings of the meeting. Mr. Addy's paper on milling cutters was, however, read and discussed. The author gave analyses of the steel used for the purpose, which appeared to approximate closely to razor steel, and by means of wall diagrams explained the mechanical principles which he considered should govern the construction of milling tools, and the machines in which they are used. Without the aid of these diagrams it would be impossible to make the subject clear, and for these we must refer our readers to the volume of the Transactions. The discussion which followed the reading of the paper turned chiefly on the speeds of cutting by milling in use respectively in this country and America; the fact that the American machinists are in advance of us in this respect being fully acknowledged by those present.

The next meeting of the Institution will be held in London early next year.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Vice-Chancellor, the Marquis of Hartington, LL.D., of Trinity College, Lord Walsingham, M.A., of Trinity College, Dr. Morgan, Master of Jesus College, Dr. A. S. Lea, Prof. Browne, Prof. Liveing, Prof. Foster, Albert Pell, M.A., of Trinity College, J. D. Dent, M.A., of Trinity College, W. Aldis Wright, M.A., of Trinity College, L. Ewbank, M.A., of Clare College, F. Whitting, M.A., of King's College, R. F. Scott, M.A., of St. John's College, J. R. Green, M.A., of Trinity College, have been appointed a Syndicate to consider the subject of the letter, dated July 25, 1890, addressed by the President of the Board of Agriculture to His Grace the Chancellor, on the subject of Agricultural Education in the University, and to report to the Senate before the end of the Lent Term, 1891.

At the annual election, on November 3, three Fellowships out of five were awarded to students of Natural Science:—Mr. R. A. Sampson, B. A. (Third Wrangler, 1888, First Smith's Prizeman, 1890), Lecturer in Mathematics at King's College, London, for researches in Hydrodynamics; Mr. L. E. Shore, M.A., M.B., B.C. (First Class Natural Sciences Tripos, 1884–85), (Senior Demonstrator of Physiology in the University, for researches in Physiology; E. H. Hankin, B.A. (First Class Natural Sciences Tripos, 1888–89), Junior George Henry Lewes Student in Physiology, for researches in Bacteriology.

Mr. Walter Heape, M.A., of Trinity College, has been elected to the Balfour Studentship in Animal Morphology, in succession to Mr. William Bateson, Fellow of St. John's College.

Mr. E. E. Sikes, Scholar of St. John's College, has been appointed by the Vice-Chancellor to hold the Newton Studentship at the British School of Archæology in Athens.

The Board for Biology and Geology propose to take power to appoint to the University Table of the Marine Biological

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